Section 4. EGS Operations

The EGS operations goals are to support EOS Program science objectives by collecting Earth science data; converting these data into useful products and making the data and products accessible to a broad user community; and coordinating the activities of widely distributed facilities, systems, networks, and organizations into a single efficient and effective operations entity. To accomplish these goals, EGS operations are divided into three major categories comprising the following functions; mission operations, science data operations, and EGS monitoring and coordination.

EGS mission operations includes the functions required for EOS space systems (instruments and spacecraft) planning and scheduling; command management, spacecraft monitoring, and orbit maintenance; and data capture and level 0 processing of EOS science and engineering data.

EGS science data operations includes the functions required to ingest and process the data and generate data products; establish and maintain EOSDIS data archives; assess the quality of the science data and user products; and provide a wide range of user services including product ordering and distribution.

EGS monitoring and coordination includes functions to perform the system-wide oversight and operations coordination necessary to ensure that EGS operations are consistent with EOS Program goals and objectives.

The functions that make up mission operations, science data operations, and EGS monitoring and coordination are briefly summarized in Table 4-1. This section presents selected scenarios to illustrate at a summary level how elements of the “as built” EGS architecture work together to accomplish the required EGS operations activities and processes. Figure 4-1 is an operations scenario roadmap intended to illustrates the interrelationships among the EGS operations scenarios presented in this section. The scenarios discussed correspond to the functions identified in Table 4-1.

This section concludes with summary level descriptions of operations support functions not addressed in the scenario descriptions, but required to maintain the systems that perform EGS operations, and to support the evolution of the mission operations, science data operations, and EGS monitoring and coordination capabilities. The operations support functions discussed are: sustaining engineering; system maintenance; EOSDIS configuration management; data management; training and certification; and operations readinesss verification.

4.1 Mission Operations

EGS mission operations includes the operations capabilities to perform planning and scheduling; command management and spacecraft monitoring; and data capture and

Table 4-1 Summary of EGS Operations Functions

Function	Operations Scenario	Description
	Planning and Scheduling	• Generate long-term plans, baseline activity profiles, and detailed activity schedules for EOS instruments and spacecraft
	Command Management and	• Perform command and control of EOS

Mission Operations	Spacecraft Monitoring	spacecraft • Monitor spacecraft telemetry to insure spacecraft health and safety • Determine and maintain the spacecraft orbit and on-board timing
	Data Capture and Level 0 Processing	• Capture and record EOS spacecraft data • Process and deliver real-time housekeeping data in real time • Generate and deliver level 0 data sets • Establish backup level 0 data archive
Science Data Operations	Data Ingest, Archiving, and Archive Maintenance	• Ingest and archive data from selected sources • Monitor and maintain the integrity of the data in the archive
	Data Processing, Ordering, Quality Assessment, and Distribution	• Generate and archive standard data products from all EOS level 0 data • Accept user orders for data products • Perform science data quality assessment • Generate and distribute products to users
EGS Monitoring and Coordination	Local EGS Management and Coordination, and EGS System-level Monitoring and Coordination	• Provides local domain specific management and operations, and inter-domain coordination • Provides EGS-wide operations status and performance reports • Provides centralized billing and accounting • Maintains current ESDIS policies and procedures • Coordinates EGS-wide problem analysis and resolution as necessary

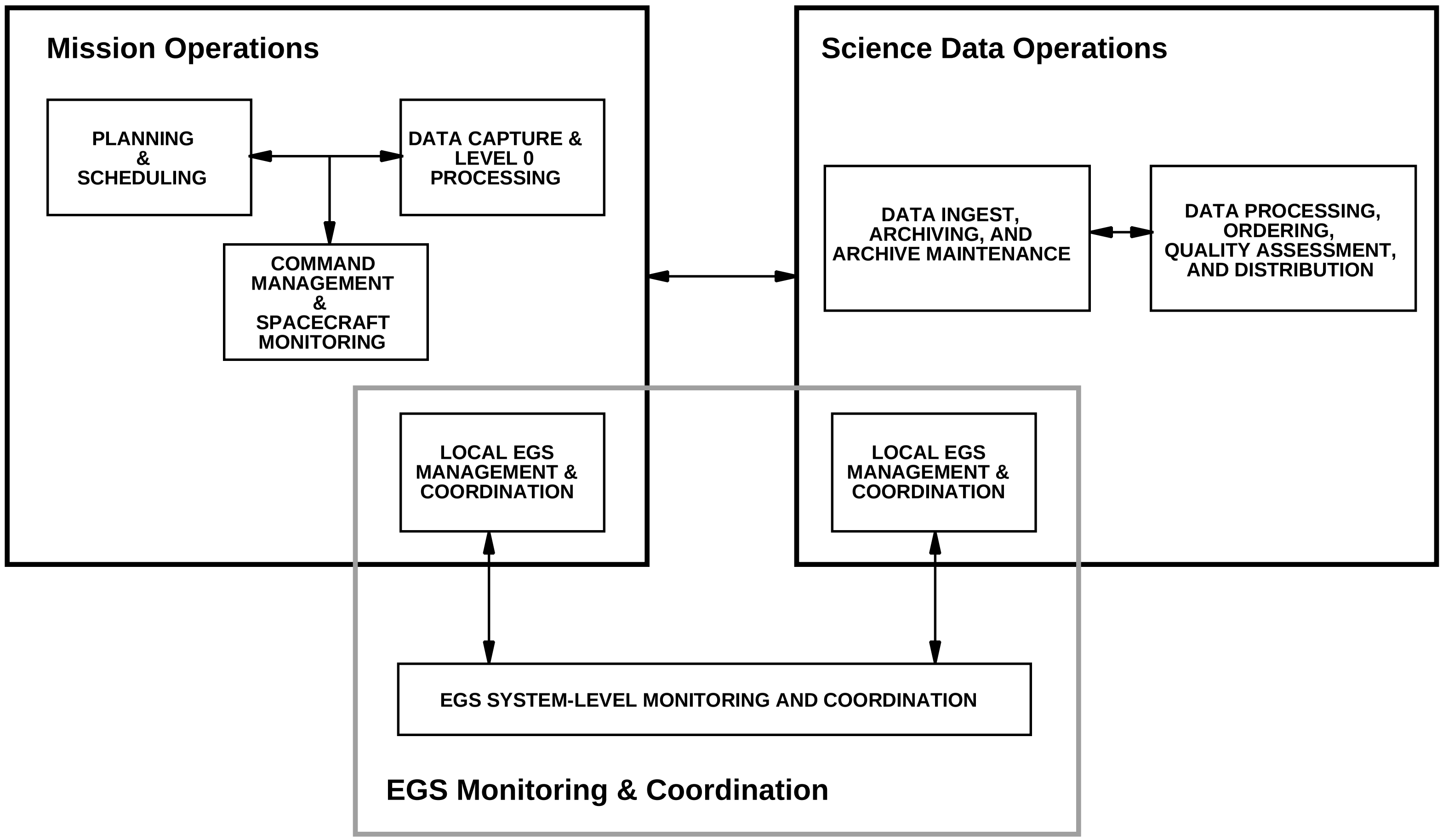

Figure 4-1 EGS Operations Scenario Roadmap

level 0 processing for EOS space systems (spacecraft and instruments). These functions are described at a summary level in this section.

4.1.1Planning and Scheduling

The planning and scheduling function produces a mission schedule that integrates the activities of the flight segment instruments and spacecraft subsystems. The science community, principal investigators (PIs), instrument operations teams (IOTs) and instrument team leaders (TLs), and international partners (IPs) have direct input and exert a major influence over the planning and scheduling of EOS instruments. Figure 4.1.1-1 identifies the EGS elements, participants, major interfaces, and operational processes involved in the performance of this function. Summary-level descriptions of these processes are provided in this section.

4.1.1.1 Long-term Planning

The long-term planning process provides the mission planning for approximately a five-year period and culminates in the development of long term plans for science, instrument, spacecraft operations, and mission activities.

The Project Scientist, the Investigators Working Group (IWG), and the science planning groups work in concert to prepare a long-term science plan (LTSP) with a planning horizon of approximately five years. The IWG updates this plan as required throughout the mission life; however, updates are expected to occur infrequently, not more than every 6 months. The LTSP establishes science priorities and objectives for each EOS mission flight. The plan may define periods of coordinated activities with other EOS spacecraft, with other Earth science missions, and with selected ground campaigns.

The LTSP is made available to PIs, TLs, IOTs, and the ASTER GDS for planning their instrument operations. The science community may also use the plan for preparing requests for data acquisition for observations by complex instruments, for coordinating correlative measurements, and for planning future science campaigns.

Using the LTSP, non-complex instrument profiles and the complex instrument profile from the ASTER GDS, and according to ESDIS Project programmatic priorities and guidelines, the PIs, TLs, and IOTs develop a long-term instrument plan (LTIP) that defines periods of instrument activity; periods in which spacecraft maintenance activity should be avoided, if possible; and periods of coordinated activity or special calibration activity when required. The contents of the LTIP are expected to be straightforward for non-complex instruments. In contrast, the LTIP has substantially more depth for complex instruments, describing the guidelines and priorities for scheduling data acquisition, targets of opportunity (TOOs), and calibration and maintenance activities. The LTIP also provides more detailed information, including periods of coordinated activities, specific targets and coverage requirements, science objectives for the upcoming period, and calibrations required before and after specific science observations.

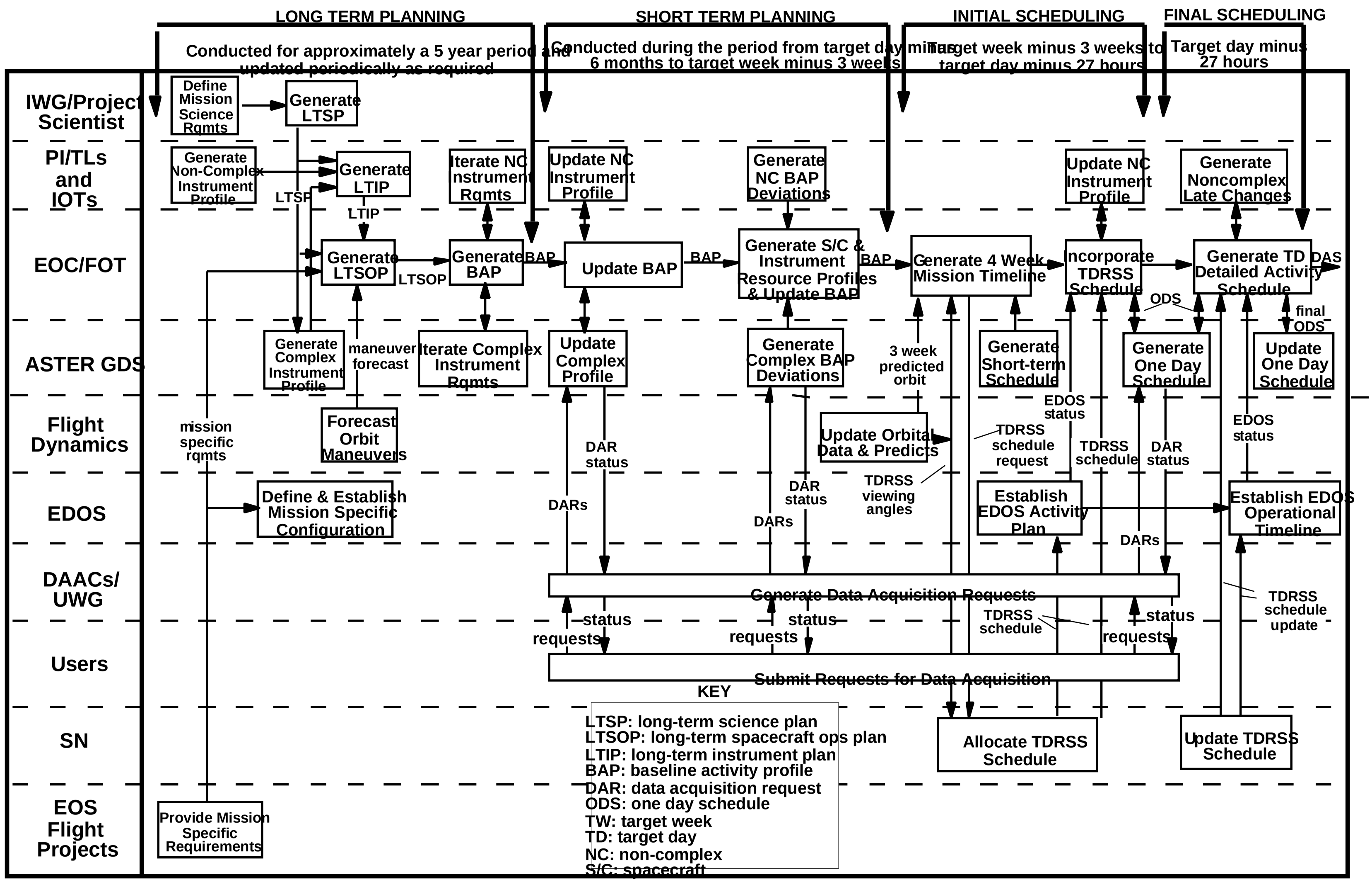

Figure 4.1.1-1 Planning and Scheduling Scenario

A long-term spacecraft operations plan (LTSOP) is developed by the flight operations team (FOT) for each spacecraft, using mission specific information provided by the flight projects, and the LTIP. Each LTSOP outlines expected spacecraft subsystem operations and maintenance, along with forecast orbit maneuvers from Flight Dynamics (FD). Spacecraft sustaining engineering and subsystem maintenance activities, subsystem calibrations, and spacecraft orbit adjustments are planned around science operations to the maximum extent possible; since these activities occur infrequently, the LTSOP is expected to be relatively straightforward. Each LTSOP is consistent with the associated LTIP and with mission specific information provided by the flight project.

Based on the LTSOP, and in conjunction with the PIs, TLs, IOTs, and IPs to identify any changes in the spacecraft operational performance, as well as upcoming spacecraft sustaining engineering and maintenance activities that may affect science operations, the FOT generates a Baseline Activity Profile (BAP). The BAP represents an integrated, operationally compatible spacecraft, instrument, EOSDIS, and institutional service plan that supports the short-term planning and scheduling processes.

4.1.1.2 Short-term Planning

Short-term planning may be required to perform needed adjustments to the BAP and to portions of the long-term plans. Typical updates are occasioned by the need to observe long-term impacts of recent TOO observations; the need to support newly created science campaigns; spacecraft, SN, or ground system resource limitations; or the submission of new data acquisition requests by users to acquire data of interest.

Non-complex instruments rarely deviate from their instrument activity profiles (IAPs); therefore, their scheduling process is often complete at this stage. However, the more complex an instrument, the more frequently deviations are expected to occur. In addition, complex instruments have generic IAPs because their scheduled activities are expected to vary significantly due to changing user acquisition requirements. The scheduling of deviations to IAPs depends upon available resources. The FOT assesses all instrument deviations from their original IAPs against available spacecraft resources in order to generate an updated BAP.

In the case of ASTER, users and investigators may want additional data and will be able to influence the EOS instrument data collection through the submission of requests for data acquisition. These users and investigators will access the EOSDIS to collect information concerning the potential for acquiring data of interest, analyze the information, and develop the request for data acquisition. Submission of the requests will be via the DAAC ECS client which will generate a data acquisition request (DAR) and forward it to the ASTER GDS instrument control center (ICC) for inclusion in the instrument activity profile. The ICC will review the DAR and issue an acceptance or rejection notice to the user or investigator via the DAAC. If accepted, the ICC will incorporate accepted DAR(s) into the IAP for the instrument so that the BAP can be updated accordingly. The DAACs also provide status information on DARs to users and investigators. Requests for data acquisition may occur at any time during the planning and scheduling process. The short-term planning process culminates in an updated BAP for instrument and spacecraft resource profiles to initiate the scheduling process three weeks prior to the target week.

4.1.1.3 Scheduling

Scheduling is carried out in two phases, initial scheduling and final scheduling.

Initial scheduling begins three weeks before the target week to resolve conflicts among requests for instrument observation time and generate a 4 week mission timeline. Conflicts will generally involve spacecraft resources related to instrument scheduling, late requests conflicting with existing scheduled activities, SN resources (AM-1 only), or contention between EOS spacecraft for X-band ground station contact periods.

Initial scheduling provides the FOT with early scheduling data to perform data management by assessing the required SN resources on the basis of the space system's accumulation of data for downlink. Before each spacecraft launch, spacecraft resources will be allocated to each instrument. It is therefore anticipated that little or no resource contention will occur among the instruments. For complex instruments however, late change DARs or TOOs could conflict with existing scheduled activities. Should conflicts arise, the FOT will initiate resolution steps with the ICC(s) and/or instrument support terminals (ISTs) representing the instruments in conflict. The final authority in conflict resolution will rest with the Project Scientist or designee for science conflicts and with the ESDIS Project Manager or designee for programmatic conflicts. The FOT will also consult with the mission operations manager (MOM) in resolving conflicts relative to the spacecraft and institutional resources.

Initial scheduling begins three weeks before the target week with the generation of a 4 week mission timeline by the FOT, resulting in a schedule request to the SN NCC for TDRSS services at approximately the target week minus two weeks. During the early part of the initial scheduling period, FD processes TONS real-time telemetry and generates three-week predicted orbits for the AM-1 spacecraft. The data are provided to the EOC for use in scheduling TDRSS coverage. In addition, FD also generates AM-1/TDRSS antenna viewing angles and times to support the EOC and the NCC in scheduling TDRSS coverage. The scheduling of EOS X-band ground stations will occur during this same time frame. The method for securing EOS X-band ground station contacts is to be determined. For either TDRSS or X-band contacts, scheduling within the multi-mission era attempts to resolve any conflicts among EOS spacecraft for the same service.

The ASTER GDS is responsible for providing the EOC with the short-term operating schedule and data rate profile for the target week, and an initial one day schedule (ODS) for the target day. An IST will provide the EOC/FOT with any schedule deviations for non-complex instruments. User and investigator acquisition requirements will be input via the DAAC and the ASTER GDS during this period. The EOC/FOT will factor in the spacecraft subsystem data rate profile to estimate the spacecraft data storage utilization and determine the SN resources required to dump the data. NCC processing of the EOC TDRSS schedule request results in an active TDRSS schedule at approximately target week minus one week.

EGS elements can either query the EOC flight segment operations schedule data bases or contact the FOT to acquire the schedules as required to support their activities.

Final scheduling begins 27 hours before the target day with the generation of a target day detailed activity schedule (DAS) by the EOC/FOT. The ISTs provide any final non-complex instrument updates. The final target day schedule is updated as necessary to be compatible with active EOS ground station schedules and/or negotiated SN schedules. Late change DARs or TOOs can be input to the ASTER GDS as late as twelve to fourteen hours before the observation time and will be incorporated into the final schedule using the negotiated space-to-ground schedule. The ASTER GDS creates the final ODS and transfers it to the EOC/FOT no later than seven hours before the operations day. Using these final inputs, the FOT generates the DAS for the target day to support spacecraft command generation. Late change DARs or TOOs incorporated into the final schedule may result in the deletion of other planned activities. Attempts are made to resolve conflicts using any flexibility in the scheduling process. The final authority in conflict resolution will rest with the

Project Scientist or designee for science conflicts and with the ESDIS Project Manager or designee for programmatic conflicts. The FOT will consult with the mission operations manager (MOM) in resolving conflicts relative to the spacecraft and institutional resources.

EGS elements can either query the EOC scheduling databases or contact the FOT to acquire summary target day activity schedules needed to support their activities.

4.1.2 Command Management and Spacecraft Monitoring

The command management and spacecraft monitoring function performs processes to command the AM-1 spacecraft and instruments, monitor spacecraft and instrument performance by analysis of the spacecraft housekeeping data, and control the orbit of the spacecraft through orbit determination, orbit maintenance, and onboard time maintenance activities. Figure 4.1.2-1 identifies the EGS elements, participants, major interfaces, and operational processes involved in the performance of this function. Summary-level descriptions of these processes are provided in this section.

4.1.2.1 Command Management

Command management is performed by the FOT at the EOC, and on board the spacecraft. Commands for the spacecraft are generated at the EOC either in real time for immediate uplink and execution or as stored commands uplinked to the

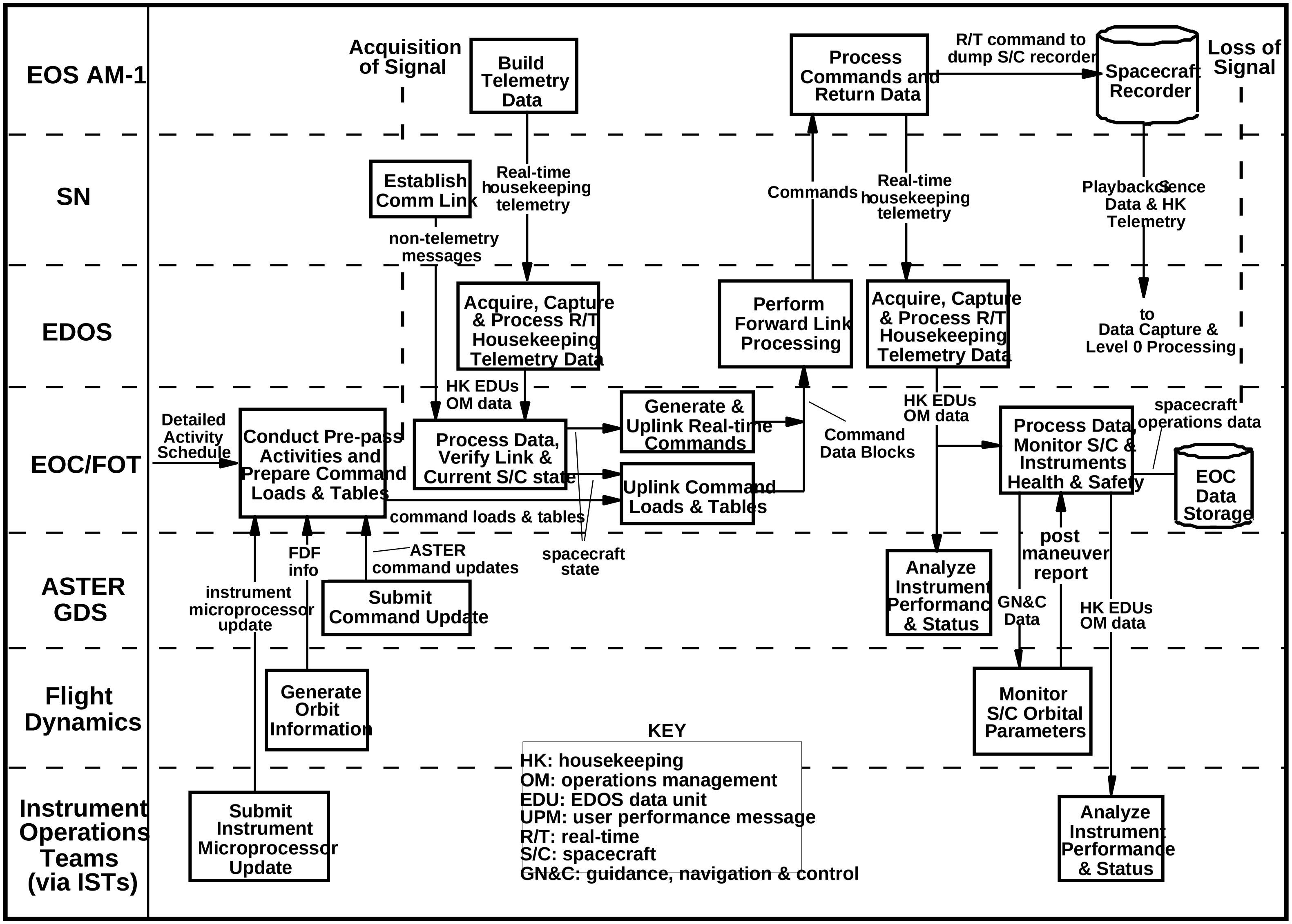

Figure 4.1.2-1 Command Management and Spacecraft Monitoring Scenario

spacecraft for execution at specified future times. Real-time commands are sent at any time during a Tracking and Data Relay Satellite (TDRS) contact, nominally to dump the onboard recorder or to react to a contingency situation. Stored command loads are nominally generated once per day for a 32-hour period and uplinked to the spacecraft 6 to 8 hours prior to the target day. The stored command period extends into the following day to ensure that the spacecraft and instruments have valid scheduled commands if the next day's command upload cannot be executed. To further insure the safety of the space system, the final commands in each stored command load configure the spacecraft and instruments into a project-defined safe condition.

The FOT in the EOC conducts their pre-pass activities which includes building a spacecraft command load and associated ground script based on the DAS, instrument command loads from the ASTER GDS and the ISTs, and orbit information through tools supplied by FD. The EOC/FOT validates the command load by performing a constraint check and critical commands check and prepares the command load. The FD orbit information is placed in tables for upload. At acquisition of signal (AOS) of the target pass, the SN acquires the downlink signal and transfers real-time housekeeping data in the form of channel access data units (CADUs) to EDOS and non-telemetry messages to the EOC. EDOS receives, captures, and processes the CADUs, extracting the housekeeping packets and producing EDOS data units (EDUs) that contain the housekeeping telemetry packet and operations management (OM) data. EDOS generates summary quality and accounting status data and transfers the packet EDUs and status data to the EOC in real time.

Processing these data, the EOC first verifies the link, begins monitoring the spacecraft and instruments, and checks the spacecraft state. The EOC ensures that the onboard command counters have incremented properly and that the downlink parameters in the housekeeping data are consistent with expectations based on the activities in the command load executing since the last spacecraft contact. If the state check is successful, real-time commands can be sent for immediate execution. Stored commands and tables also may be uploaded.

EDOS receives real-time commands and/or stored command tables as command data blocks, constructs the forward bit stream, and transmits the commands to the spacecraft through the SN. The spacecraft examines all commands received and indicates acceptance or rejection by the use of command link control words (CLCWs) inserted into the real-time housekeeping telemetry. CLCWs are stored in onboard memory and also transmitted to the ground as part of the real-time housekeeping telemetry data stream. Using CLCW data from the spacecraft which are received at the EOC via EDOS (as part of the spacecraft monitoring process), the EOC/FOT confirms real-time command receipt and execution and successful stored command loading. If either is unsuccessful, the FOT takes appropriate action.

4.1.2.2 Spacecraft Monitoring

During each TDRS contact space system real-time housekeeping data are continuously received and processed by EDOS in real time and immediately sent to the EOC and the ASTER GDS. The EOC/FOT, the ASTER GDS, and the IOTs monitor and analyze the spacecraft and instrument housekeeping data continuously during a contact, to verify the health and safety of the spacecraft and instruments. By continuous examination of the spacecraft housekeeping data, the FOT can react immediately to any non-nominal situation. Housekeeping data are recorded on board the spacecraft along with the science data throughout the complete spacecraft orbit. These data are dumped to the ground, processed by EDOS, and sent to the EOC to provide a complete record of the housekeeping data for the entire orbit for later analysis and as a historical record.

EDOS acquires, captures, and processes the real-time housekeeping telemetry from the spacecraft, extracts the CLCWs from the CADUs, and forwards the CLCW EDUs to the EOC. Using the housekeeping data and the CLCW EDUs, the EOC confirms both real-time command receipt and execution, and successful stored command loading. If the load is unsuccessful, the CLCWs provide the FOT with the knowledge to upload the stored commands a second time or investigate the cause of the rejection. The EOC extracts guidance, navigation and control (GN&C) data and provides it to FD. The EOC and ICCs continue to monitor the spacecraft and instrument housekeeping parameters until loss of signal (LOS). The EOC provides selected spacecraft data to the IOTs.

Housekeeping data are stored in spacecraft memory twice, as part of the science data storage and in a separate housekeeping storage; either may be used for normal housekeeping monitoring. Before LOS, science and housekeeping data accumulated over the previous orbit are dumped via a real-time command sequence. EDOS acquires and captures the spacecraft memory dump and stores the processed housekeeping EDUs. Within five minutes after LOS, EDOS rate-buffers the playback housekeeping EDUs to the EOC. The EOC adds the playback EDUs to the history log to provide a complete record of housekeeping data for the entire orbit for later analysis by the EOC, the ASTER ICC, and the IOTs.

4.1.2.3 Orbit Determination and Maintenance

AM-1 orbit determination is performed on board in real time by the TDRS Onboard Navigation System (TONS) with ground-generated ephemeris providing a backup capability. TDRS position vectors and backup ground computational support are provided by FD for daily uplink to TONS. TONS calculates spacecraft position in real time, and also includes TONS spacecraft ephemeris in the housekeeping data. EDOS captures both the real-time telemetry data and the playback data, extracts the housekeeping data, and sends it to the EOC. The EOC provides TONS spacecraft ephemeris to FD to monitor changes in spacecraft orbital position and verify TONS performance.

The EOC performs on board time maintenance by monitoring the spacecraft clock offset from the universal time received from the U.S. Naval Observatory, preparing and uplinking spacecraft clock update commands whenever the clock approaches the predetermined error limit, and verifying that the spacecraft clock was correctly updated.

Orbit adjust maneuvers are performed as needed to maintain the AM-1 spacecraft orbit within the specified parameters. FD monitors the ephemeris, analyzes the orbit, and as necessary, prepares an orbit adjust maneuver plan for the EOC to execute. Based on the FD plan, the FOT prepares the maneuver command sequence, uplinks the command sequence to the spacecraft, and executes an orbit adjust maneuver. The results of the orbit adjust process are monitored by the FOT and FD in order to make any required adjustments necessary to achieve the desired orbit correction. FD generates a post-maneuver report and sends it to the EOC/FOT

4.1.3Data Capture and Level 0 Processing

The data capture and level 0 processing function receives and captures spacecraft data; processes the data to create level 0 expedited data sets and production data sets; distributes level 0 data; and stores all level 0 data long-term in a backup archive. Figure 4.1.3-1 identifies the EGS elements, participants, major interfaces, and operational processes involved in the performance of this function. For clarity, certain processes from the previous command management and spacecraft monitoring scenario are repeated (shaded on the figure). Summary-level descriptions of these processes are provided in this section.

4.1.3.1 Data Capture

During a TDRS contact EDOS acquires and captures the high rate Ku-band data stream, which contains both science and housekeeping playback data, from the SN return link. EDOS subsequently processes the physical channel data, generates operations management (OM) status data, and separates the playback science and housekeeping data into virtual channel data units and packets. Based on the intended destination, these data are sent as EDUs to EDOS level 0 processing functions or distributed directly as EDUs to other facilities. Throughout the TDRS service session (TSS), EDOS continuously monitors the data capture and initial processing and reports operations management status to the EOC. All CERES instrument data in the form of EDUs are sent directly to NOAA.

4.1.3.2 Level 0 Processing

Level 0 processing begins at the conclusion of a TSS. EDOS initiates level 0 processing based on data priority. Data identified for expedited delivery are processed first and delivered as expedited data sets (EDSs). Production data sets (PDSs) are generated for delivery to science processing facilities.

The SN notifies the EOC of loss of signal (LOS) indicating termination of contact. The EOC performs post-event operations to assemble a complete record of housekeeping data for later analysis. EDOS independently detects LOS and begins post-event operations, including generating a summary OM data status message for the EOC; initiating the rate-buffered transfer of CERES EDUs to a NOAA facility; and transmitting rate-buffered housekeeping EDUs containing a full orbit’s data and possibly redundant data packets to the EOC and ASTER GDS.

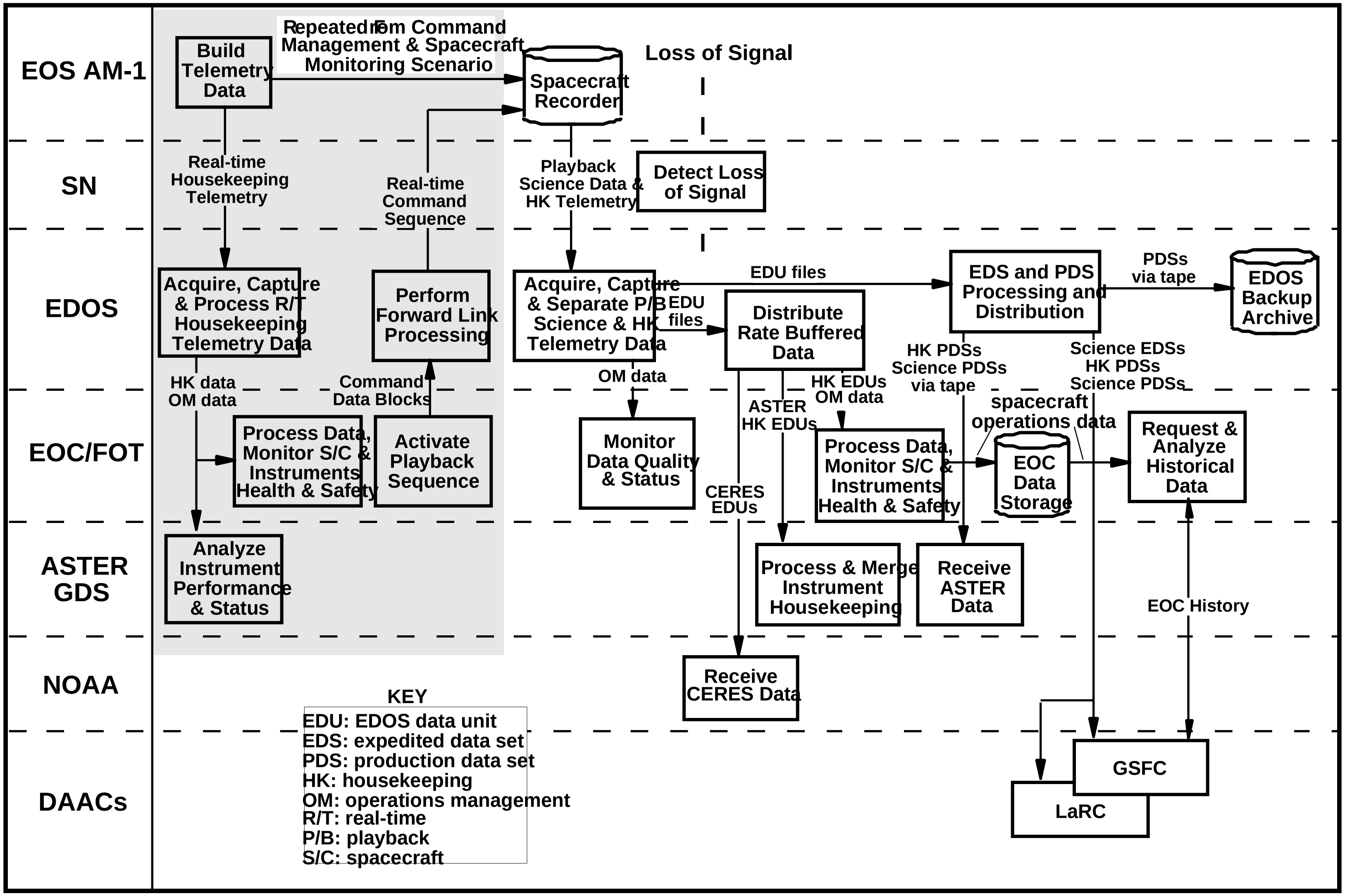

Figure 4.1.3-1 Data Capture and Level 0 Processing Scenario

EDSs are processed ahead of the PDSs. The content of the output EDS is limited to either all packets received for a single APID during one TSS, or all packets in one TSS in which the expedite flag is set in the data packet secondary header. Redundant packets within an EDS are removed. However, since EDS processing focuses on a single TSS and does not take into account any data that arrived in a previous TSS, redundant packets between service sessions are not removed. Therefore, two EDSs could contain redundant data. The packets contained in an EDS are included in production data processing for the corresponding TSSs. The normal volume of expedited data processing is limited to a small percentage of all return link data received over a 24-hour period. EDSs consisting of packets received during one TSS are distributed to the DAACs.

Level 0 processing is performed for all data, including the data previously processed for expedited delivery, to remove communication artifacts such as headers; sort data by application identifier; forward time order the data; remove duplicate data; and perform data quality checks. Level 0 production data sets (PDSs), with quality and accounting data appended, are constructed and delivered either electronically or on physical media to the appropriate destination. All level 0 PDSs are also recorded on physical media and sent to the EDOS backup archive. The DAACs receive science EDSs and science and housekeeping PDSs for further processing. ASTER data are sent directly to the ASTER GDS on physical media.

The GSFC DAAC maintains housekeeping PDSs to enable the EOC to access a full record of spacecraft and instrument housekeeping data for future analysis. This record provides a complete, non-redundant data set that replaces the earlier rate buffered housekeeping EDUs.

4.2 Science Data Operations

Nine Distributed Active Archive Centers (DAACs) representing a wide range of Earth science disciplines have been selected to carry out responsibilities for processing, archiving, and distributing EOS and related data, and for providing a full range of user support. DAACs provide custodianship for the data during and ensure that data are readily and promptly available to users. Acting in concert, the DAACs provide reliable and operationally robust services to global change researchers whose needs cross traditional discipline boundaries, while continuing to support the needs of their individual discipline communities.

EGS science data operations includes the operations capabilities to perform science data ingest, archiving, and archive maintenance; and science data processing, ordering, quality assessment, and distribution. These functions are described at a summary level in this section.

4.2.1Science Data Ingest, Archiving, and Archive Maintenance

The science data ingest, archiving, and archive maintenance function ingests and archives EOS data and selected non-EOS data at the EOSDIS DAACs, and monitors

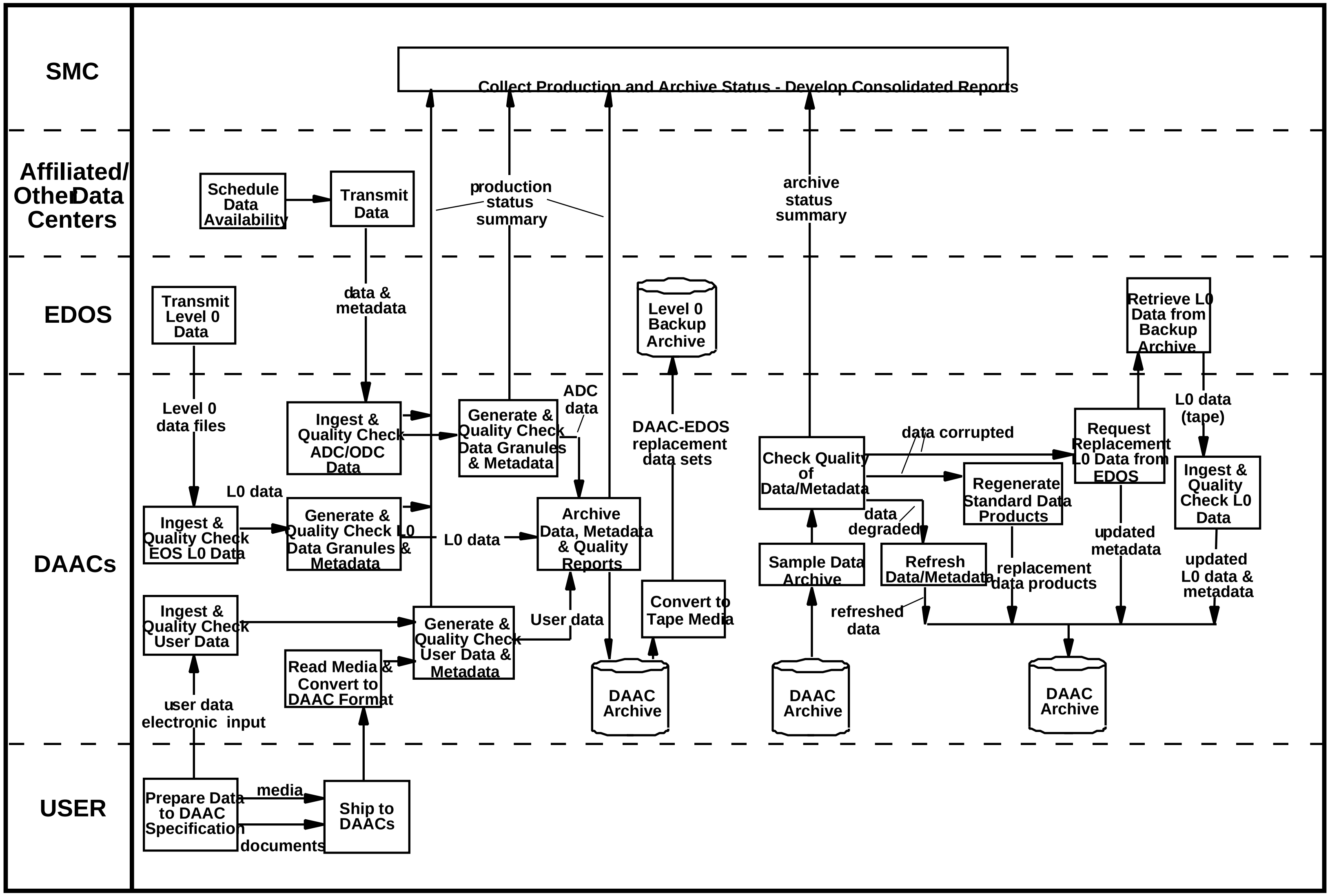

Figure 4.2.1-1 Data Ingest, Archiving, and Archive Maintenance Scenario

and maintains the integrity of the the data stored in the DAAC archives. Figure 4.2.1-1 identifies the EGS elements, participants, major interfaces, and operational processes involved in the performance of this function. Summary-level descriptions of the processes are provided in this section.

4.2.1.1 EOS Data Ingest and Archiving

The EDOS transmits EOS level 0 data files to the EOSDIS DAACs using standard, commercially available, guaranteed data delivery protocols. These protocols implement error detection and correction schemes through encoding and/or retransmission. The EOSDIS DAACs ingest EOS level 0 data files and associated ancillary data from EDOS and perform automated quality checks to verify that the data are received correctly in a time-ordered sequence with no gaps; if necessary, the DAAC requests that incomplete data be resent by EDOS.

Following the ingest process, the DAACs generate level 0 data granules (the smallest aggregation of data that is independently managed), extract the ancillary data, and create metadata that describe the level 0 granules. Automated quality checks are performed on the level 0 granules, metadata, and ancillary data for validity, internal consistency, and completeness. The level 0 data and the associated metadata and automated quality reports are entered into the DAAC archive. If level 0 data in the EDOS backup archive is lost or damaged, EDOS can request replacement of this data from the appropriate DAAC. The required data are converted to physical media and sent to EDOS as DAAC to EDOS Data sets (DEDs).

The EOSDIS DAACs routinely provide DAAC production status summary information to the System Monitoring and Coordination Center (SMC). The SMC provides the ESDIS project the capability and tools to maintain programmatic and scientific oversight and to coordinate EOSDIS DAAC resources and operations as necessary.

4.2.1.2 ADC/ODC Data Ingest and Archiving

The EOSDIS DAACs ingest and archive other NASA Earth science data from affiliated data centers (ADCs) and other data centers (ODCs) that are part of MTPE. This may include data from other earth observing projects, such as TRMM and Landsat; special projects with EOS instruments on other spacecraft, such as flights of opportunity; and non-EOS programs. Data from these sources may also be required to generate special products. The EOS Program negotiates agreements with other agencies, including international organizations, to acquire and use these data. Agreements between the ESDIS Project and the responsible source organization define the type of data and identify the appropriate DAAC to receive the data.

Data are received from ADCs and ODCs in the form of level 0, ancillary, or processed data sets, with the associated metadata, according to rules defined by the DAACs. The data generally are received electronically; however, DAACs are able to accept and read data from physical media.

DAACs and ADCs/ODCs coordinate the availability of data. ADCs/ODCs schedule their data availability and notify the DAACs with a data availability notice, which specifies the time limit that the data will be held for pickup. The DAACs schedule and perform the ingest of data from the ADCs/ODCs within the specified data availability time limits. Any deviations from the schedule are negotiated between the DAAC and the ADCs/ODCs. After ingesting the ADC/ODC data granules and associated metadata, the DAACs immediately perform automated quality checks to verify that the data specified in the data availability notice are correctly received. If necessary, the DAAC requests that incomplete data be resent.

Following the ingest and quality checking process, the DAAC extracts the identifying information from the incoming data files, combines the results of the quality check, and generates new metadata for the product. Automated quality checks are performed on the data granules, metadata, and ancillary data for validity, internal consistency, and completeness. The data granules, metadata, and automated quality report are assembled and entered into the DAAC archive, and the DAAC inventory is updated. As negotiated, level 0 data from ADCs/ODCs may be sent to EDOS as physical media for entry into the backup archive.

4.2.1.3 User Data Ingest and Archiving

Selected users may provide data, data products, analysis results, analytical software, or reports to the EOSDIS DAACs to be made available to other users. These data can be sent to the DAAC in the form of electronic files, physical media, or printed documents. DAACs ingest these data, assess their quality, convert to a DAAC compatible format as necessary, and store them with the associated metadata in the archive for use in generating products to fill user orders. User data submissions to a DAAC also may not include the complete data set, but consist of catalog and directory information identifying what data are available and how to access and order it. In this way, data holdings at a users facility are made available to the general user community without necessitating the transfer of the physical data to a DAAC.

The user logs on to a DAAC, completes the validation process, and requests to submit data from a menu of options. A local user review board at each DAAC determines which products will be allowed for submission. When the DAAC accepts the request, it provides instructions and aids to guide the user in preparing data or documents, and associated metadata for submission to the DAAC. The user prepares the materials and delivers them to the DAAC, either electronically or as hard media.

For non-electronic delivery, the user prepares the data and metadata on hard media clearly labeled with identifying information; follows the instructions provided by the DAAC to put the data in a form acceptable to the DAAC; and ships the medium to the DAAC address designated in the instructions. The DAAC reads the media and if necessary, converts it to a digital format. For hardcopy documents, the user provides a clearly labeled text document with identifying information to the address provided. The DAAC converts the text to machine-readable format.

Once the data are in an electronic format, the DAAC performs an automated quality check on the data from all sources. If the data are corrupted or not acceptable, the DAAC will request replacement data by asking the user to prepare and retransmit the data.

The DAAC extracts the identifying information from the data files, combines the results of the quality check, and generates metadata for the product. The data, metadata, and quality report are assembled and entered into the DAAC archive, and the DAAC inventory is updated.

4.2.1.4 Archive Maintenance

The EOSDIS DAACs routinely audit their data archive holdings to determine the health and status of the data in the archive; to validate the product inventory; and to maintain the data quality level of the archive.

Archive maintenance is performed by each DAAC for its data archive holdings. The data, metadata, and ancillary data are retrieved from the archive, inventory data are generated, and data product maps are prepared that cross-reference the metadata to the data granules and associated ancillary data. A product inventory database containing this information is established. In addition, the data location map is monitored for online storage utilization. Inactive files are removed, and the archive storage is compressed to maintain efficient storage utilization.

Archived data are checked to determine whether the data have degraded beyond the error limit set for the archive medium. The data are refreshed if the error limit has been exceeded, and a second check is made to determine whether the data are corrupted. If the data are corrupted, the metadata are updated to reflect the change in quality and DAAC operations personnel are alerted to initiate corrective action. If a standard data product is corrupted but the corresponding level 0 data quality is OK, then the standard data product and metadata are regenerated and placed in the archive to replace the corrupted product. If the corresponding level 0 data is also corrupted, then replacement level 0 data is requested from the EDOS backup archive
to maintain the active DAAC archives.

4.2.2 Science Data Processing, Ordering, Quality Assessment, and Distribution

The science data processing, ordering, quality assessment, and distribution function generates and archives standard data products from all EOS level 0 data; accepts user orders for data products; performs science data quality assessment; and generates and distributes products to users. Figure 4.2.2-1 identifies the EGS elements, participants, major interfaces, and operational processes involved in the performance of this function. Summary-level descriptions of the processes are provided in this section.

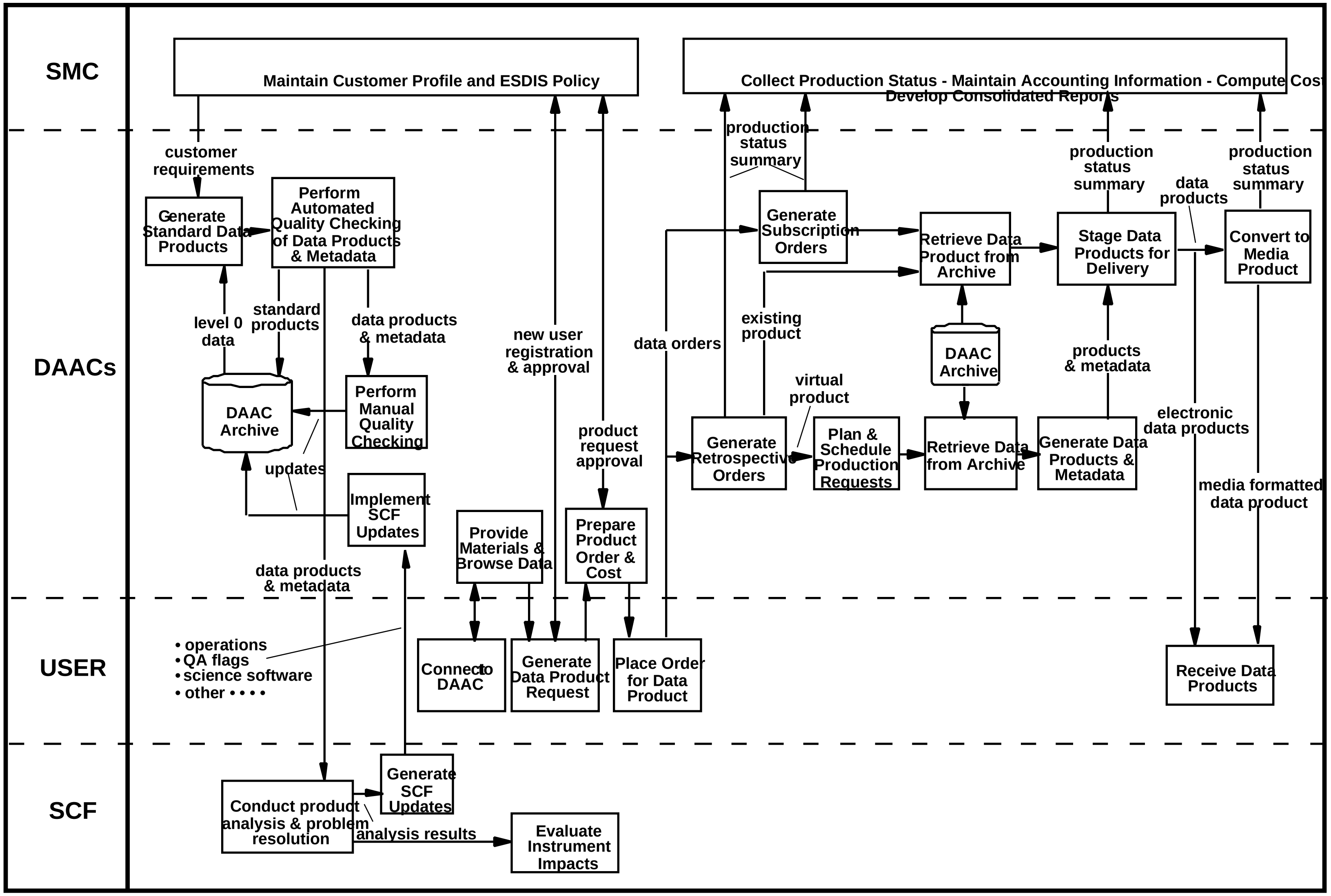

Figure 4.2.2-1 Data Processing, Ordering, Quality Assessment, and Distribution Scenario

4.2.2.1 EOS Data Processing

Following the EOS level 0 data ingest and archiving process, standard data products and associated metadata are generated from all EOS level 0 data in the DAAC archives according to a predefined set of requirements and criteria jointly established by the DAACs and the science community. An automated quality check is performed on the products and metadata; the standard products, associated metadata, and quality reports are entered into the DAAC archive, and the DAAC inventory is updated.

4.2.2.2 Product Ordering and Distribution

The EOSDIS DAACs provide a wide range of services that enable users to efficiently and effectively interact with the EOSDIS to place orders for products. These include services to: register as a user; obtain help and tutorial support; search and query data holdings; browse and order existing data granules; request acquisition of specific data; determine the status of orders; and receive products.

There are two basic types of orders processed by the DAACs; subscription orders and retrospective orders. A summary-level description of each is provided in the following sections.

4.2.2.2.1 Subscription Order Processing and Delivery

Subscription order processing is an extension of the standard data product generation and archiving process discussed in section 4.2.2.1. Subscription order processing allows authorized users to request, in advance of acquisition, all standard data products that meet their specified criteria. Whenever a user has entered a subscription order into the system, the requested standard data products are retrieved from the archive, staged for delivery, and delivered to the user automatically each time the requisite data are acquired and the standard data product is produced. The user need take no further action.

In addition to standard data products, users can also place subscription orders for level 0 products. Level 0 products are staged for delivery immediately after being assembled into a predefined format. Once staged for delivery, data products are delivered to the user electronically or as physical media. The product order and cost information are sent to the SMC where an itemized invoice is prepared and sent to the user, and the user's account is debited for the cost of the product.

4.2.2.2.2 Retrospective Order Processing and Delivery

Retrospective order processing allows users to order a data product from a list of existing and “virtual” products. A virtual product appears as an existing product to a user since metadata exists to describe it, but the product is only produced when an order for it is received. The existence of metadata indicates that all data required to produce the product is available in the DAAC archive.

To initiate a retrospective order, the user logs onto the system, is validated as an approved user, and an interactive session is initiated between the user's workstation and the DAAC. At the beginning of the session, the user is notified of the status of any outstanding orders in their account. The user then selects and reviews the appropriate data catalogs, identifies the data desired, and requests the corresponding metadata. The requested metadata are provided to the user's workstation regardless of which DAAC the metadata resides in; the location of the desired metadata is transparent to the user. The user examines the metadata and generates a data product request.

The DAAC computes the price of providing the requested product, queries the user's account in the SMC to verify that the user has the proper data access authorization and that sufficient funds are available in their account to pay for the product. The DAAC then returns either an itemized product order and estimated price to the user, or rejects the product request and identifies the reason for the rejection. The user then places an order or terminates the session.

If an order is initiated, the DAAC determines whether the requested product is available directly from a DAAC archive. If available, the DAAC retrieves the requested product from the archive and stages the product for delivery. The location of the data product is transparent to the user; it may be located in any DAAC. If the requested product is not available directly from the archive but must be specially produced, the DAAC determines what additional processing is required, plans and schedules a production request for the product, retrieves and stages the necessary data, and produces the required product and associated metadata. If desired, and the user has the proper approval, their retrospective order may be converted into a subscription order so that from that time on, the DAAC will automatically produce the special product whenever the data necessary to produce it is available, and ship it to the user with no further action required by the user.

After the product is produced, product quality is automatically assessed against predefined criteria and a quality report is generated. Product metadata are updated; and the new product, its corresponding metadata, and quality report are staged for delivery. Once staged for delivery, data products are delivered to the user, electronically or on physical media. The product order and cost information are sent to the SMC, where an itemized invoice is prepared and sent to the user, and the user's account is debited for the cost of the product.

The EOSDIS DAACs routinely provide DAAC production status summary information to the System Monitoring and Coordination Center (SMC). The SMC provides the ESDIS Project the capability and tools to maintain programmatic and scientific oversight and to coordinate EOSDIS DAAC resources and operations as necessary.

4.2.2.3 Science Data Quality Assessment

Science data quality assessment is performed on instrument data as part of routine instrument performance evaluation, and processed data are examined to assess the accuracy of the science algorithms provided by investigators and to evaluate EOSDIS DAAC system performance. All instrument data and data products are routinely screened, and subsets of the data are subjected to in-depth analysis.

The scenario depicted in Figure 4.2.2-1 represents the period well after instrument activation when both instrument performance and related standard data product generation software are well understood. The scenario is limited to quality assessment of standard data products. That is, data quality assessment processes applied to other science data types, such as ancillary data, Version 0 data, or other external datasets, are not considered here but are expected to be similar. Three levels of quality assessment are performed to monitor and evaluate the various science data products produced during production operations.

The first level, automated quality screening, incorporates software-based screening routines embedded in the science software to automatically evaluate all generated products and identify those products that do not meet predefined assessment criteria defined by the instrument team. The quality of the data products is recorded on production processing summary reports, and product metadata is updated as a result of the automatic screening. Production history logs record the complete history of each production job to facilitate the resolution of processing anomalies or other abnormal results.

The second level is performed by trained DAAC operations personnel, using more sophisticated quality assessment tools and procedures. This level of assessment is generally performed whenever the automated quality screening produces a non-nominal result, as well as on a procedural basis where samples of data products are routinely subjected to a more in-depth quality assessment. DAAC personnel examine production history logs, product metadata, and the actual data products as necessary to identify data quality problems and isolate their cause. The DAAC personnel determine if a real data or processing software problem exists, or whether some other reason is the cause. The problem may, for example, only be a configuration control problem, such as the use of an incorrect calibration file. In that case, DAAC personnel schedule the necessary reprocessing and delete the incorrect products from the system. If a genuine data or processing algorithm problem exists that the DAAC personnel cannot resolve, they notify the instrument team of the situation.

Finally, instrument teams at the SCFs perform the third and highest level of data quality assessment. In order to monitor changes in instrument performance and record long term trends, the instrument team places subscription orders for selected data products which are automatically produced and sent to the instrument team for in-depth quality assessment The instrument teams at the SCFs also perform the in-depth analysis that may be necessary to determine the cause of a data or processing software problem. These problems may be detected as a result of the previous quality screening activities, or may result when the users of data products report product anomalies discovered in the process of using the data in their work.

As with the potential causes of a data problem, multiple solutions are possible. Some problems may be corrected with updated calibration files, minor adjustments to algorithms, or modifications to data formatting routines. Other problems may be caused by systems outside the control of the instrument team. Instrument or spacecraft problems may require the development of entirely new algorithms to correct the problem. Certain types of spacecraft problems may require an evaluation of the impact on the instrument, and may necessitate changes to the way the instrument or spacecraft is operated or scheduled. Updates to the screening routines may be required to eliminate false alarms on data quality or to introduce additional checks not planned for during initial development. Reprocessing of some of the instrument data may be necessary because of changes in software or calibration parameters.

The PI or TL will coordinate with the project scientist to arrange for the allocation of resources and schedules for any required reprocessing. Product metadata will be updated to reflect changes in data quality assessment, as required. Users will be notified when data products they have previously received are determined after the fact to have quality problems.

4.3 EGS Monitoring and Coordination

EGS monitoring and coordination equals EOSDIS monitoring and coordination plus monitoring of and coordination with other EGS element interfaces. It is comprised of two components; local EGS management and coordination, and EGS system-level monitoring and coordination. It includes the operations capabilities to provide EGS-wide operations status and performance reporting; provide centralized billing and accounting; maintain current ESDIS policies and procedures; and coordinate EGS-wide problem analysis and resolution as necessary. Figure 4.3-1 identifies the EGS elements, participants, major interfaces, and operational processes involved in the performance of the EGS monitoring and coordination function. A summary-level description of this function and its capabilities is presented in this section.

4.3.1 Local EGS Management and Coordination

The local EGS management and coordination function provides local domain specific management and operations and inter-domain coordination via ECS provided local system managers (LSMs). LSMs provide local management services to manage the ECS-provided capability and resources at each distributed ECS site (i.e., the DAACs and the EOC). Each ECS site and element, through its LSM component, schedules and performs its own internal real-time operations and resource management functions, subject to coordination from the System Monitoring and Coordination Center (SMC).

In addition to the ECS LSM functions, local operations management functions internal to EDOS, EBnet and the external network, and other EGS elements schedule and perform the internal real-time operations and resource management of those elements. Each element has the capability to exchange a wide range of status and

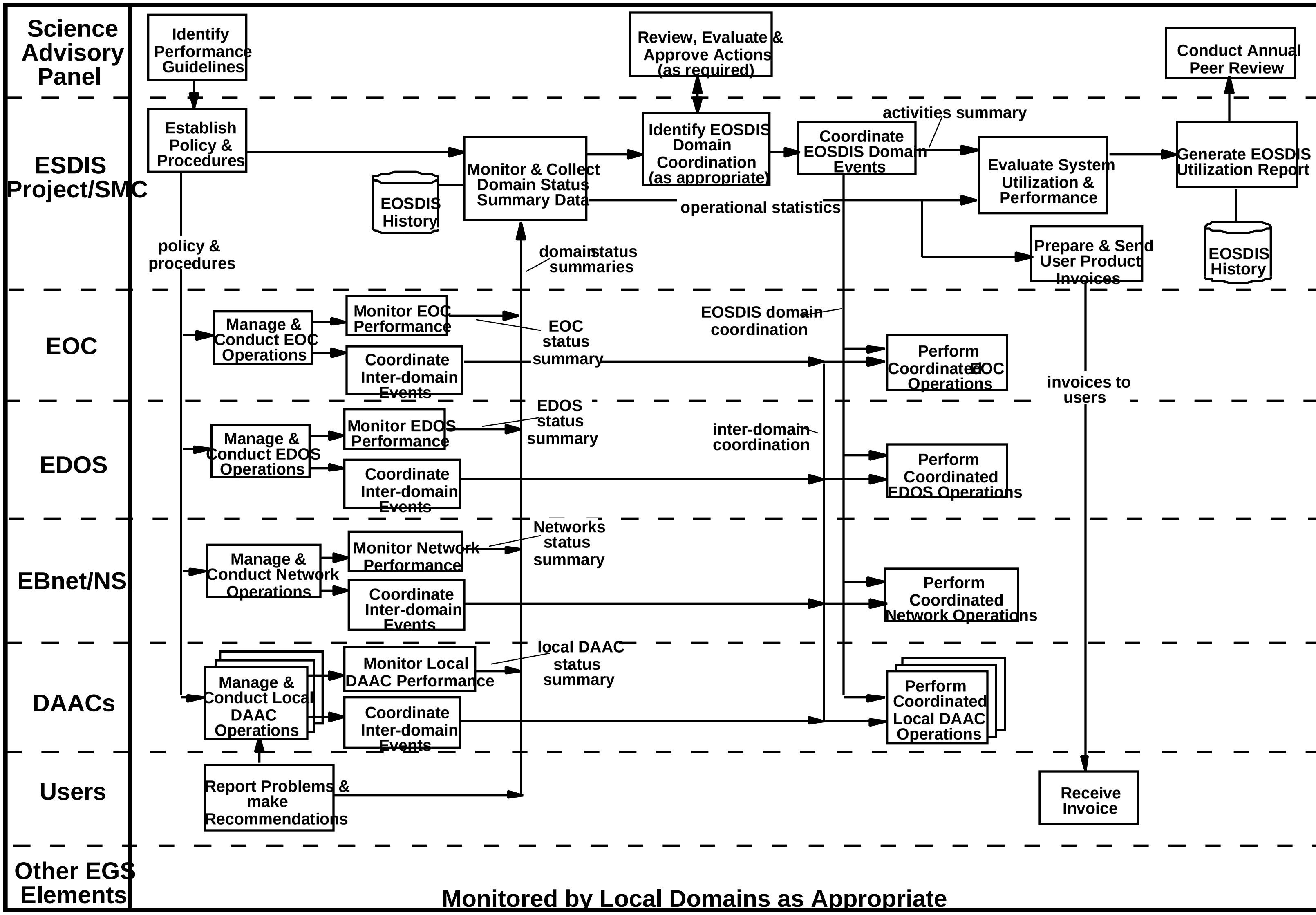

Figure 4.3-1 EGS Monitoring and Coordination Scenario

coordination data with the SMC. Each element can also perform inter-domain coordination by exchanging status and coordination information directly, not via the SMC. In this manner, EGS elements can resolve local issues without SMC involvement. EOSDIS local domains also provide status information to the SMC pertaining to their external interfaces with other EOSDIS domains, institutional service providers, or other end users, allowing the SMC to maintain a current system-wide view of the EGS operational status.

4.3.2 EGS System-level Monitoring and Coordination

The EGS system-level monitoring and coordination function enables the ESDIS project to maintain a current EGS-wide operational view and perform EOSDIS system-level monitoring and coordination. EOSDIS real-time operations management services are performed by the three major operational EOSDIS elements, the ECS, EDOS, and EBnet. Each of these elements manages its own internal real-time operations and their interactions with external elements, and interacts with the other elements to coordinate and facilitate end-to-end EGS non-real-time system management. The ESDIS project maintains a current view of interactions with external EGS elements and coordinates with them when necessary. The ESDIS project role is to oversee, monitor, and coordinate when necessary with minimum interference in internal domain operations.

The focal point for EGS monitoring and coordination is the System Monitoring and Coordination Center (SMC), a component of the ECS. The SMC provides the tools and capabilities necessary to perform the monitoring and coordinating of ECS resources at the individual site level and for EOSDIS system-wide resources. The SMC monitors operations of all distributed ECS sites via LSMs, and coordinates as necessary. The SMC collects, collates, and assesses operations management data across the end-to-end EOSDIS to provide system level reporting and inter-element operations coordination as necessary. The SMC generates a wide variety of operational and administrative reports for the ESDIS project in support of day-to-day EGS operations management. The SMC also provides the data necessary to support the annual peer review assessment by the Science Advisory Panel of product use, system use, and user satisfaction.

Some of the key services provided by the SMC are: maintaining ESDIS policies and procedures; billing and accounting; scheduling; configuration management; performance management; fault management; security management; and operations analysis. Summary-level descriptions of these services are provided in this section.

4.3.2.1 Maintaining ESDIS Policies and Procedures

The SMC is the focal point for maintaining and distributing ESDIS policy, procedures and directives. Current ESDIS policy and procedures are maintained using office automation tools. Policy, procedures, directives, updates, and advisories are distributed via document data server, EMail, and bulletin board.

4.3.2.2 Scheduling

The scheduling process provides system-wide planning for and scheduling of ground events. Ground events are typically defined as non-production activities such as maintenance, testing including mission level testing and simulations, demonstrations, software upgrades, etc. The SMC will develop candidate plans for activities which impact multiple sites, and send the plans to the sites for integration into their production plans. The process supports scheduling of non-ECS events which impact ECS resources. The SMC will adjudicate conflicts with sites or between sites by supporting sites in resolving conflicts, setting priorities, and allocating resources. The SMC will develop high level plans for site resource utilization; provide a framework within which sites allocate resources for production and user support; identify bottlenecks for common resources such as network bandwith; and identify resource requirements for scheduled ground events.

4.3.2.3 Billing and Accounting

The SMC receives billing and accounting information from DAACs. This includes details of user activity from each DAAC. ESDIS policy dictates common and standard pricing for products across DAACs. Based on this policy, the SMC generates and distributes bills and utilization information to registered users; receives direct payments from registered users; receives indirect payment from DAACs (if DAACs are permitted to accept payment); maintains account limits and balances for registered users; and provides limit and balance information to DAACs.

4.3.2.4 Configuration Management

The configuration management process maintains and manages the operations baseline configuration at local sites, assesses and approves configuration changes with potential system-wide impacts prior to local implementation, manages system-wide configuration upgrades, and audits local configuration status as required.

4.3.2.5 Performance Management

The performance management process provides performance criteria and metrics to all EOSDIS elements; establishes site level performance reporting criteria; monitors and evaluates EOSDIS site and element performance and performance trends; generates fault or degradation alerts; and compiles and assesses system-wide performance data to coordinate corrective action as necessary.

4.3.2.6 Fault Management

The fault management process provides real-time support for fault isolation, diagnosis, analysis, and recovery coordination; provides a common point of contact to external systems; identifies and isolates EOSDIS site and element fault conditions; provides system-level coordination as required to resolve faults; and compiles and evaluates system-wide fault history to recommend changes if needed.

4.3.2.7 Security Management

The security management process disseminates security policy; detects and monitors security events, including breach attempts, at the local element level and coordinates action across system elements as required; notifies all EOSDIS elements of any site breach attempt or other major security event; and coordinates security matters with external security agents as necessary. The SMC collects security status information from all EOSDIS elements for use in evaluating the effectiveness of the EOSDIS-wide security process.

4.3.2.8 Operations Analysis

The operations analysis process generates a wide-range of summary operations reports to ESDIS. The SMC collects DAAC operations statistics such as: planned versus actual throughput; production and reprocessing backlog; registered and guest user activities; product request summaries; performance statististics; and resource faults and failures. The SMC collects statistics on external system interface performance such as network performance and data delivery metrics; billing and accounting summaries; and sustaining engineering activities; configuration status; system-wide security status summaries; and system-wide fault histories.

4.4 Operations Support

In addition to the operations functions described in Sections 4.1, 4.2, and 4.3, the EOSDIS elements perform several major operations support functions required to carry out EOS mission operations. These functions include sustaining engineering; system maintenance; EOSDIS configuration management; data management; training and certification; and operations readiness verification.

Element operations and maintenance (O&M) organizations provide the resources required to perform operations support functions, including the administrative and management functions necessary to operate element facilities. The EOSDIS development contractors maintain and operate the EOSDIS systems until these responsibilities transfer to the O&M organizations. The EOSDIS development contractors support this transition by providing training, up-to-date documentation, supporting data and information, and any special software or other tools required to maintain the operational systems.

The EOSDIS operations support functions are summarized in this section.

4.4.1 Sustaining Engineering

The EOSDIS sustaining engineering function monitors system-level operations and analyzes trends in performance, capacity, and reliability, maintainability, and availability (RMA); maintains system-level requirements and evaluates the impact of proposed changes in EOSDIS requirements; assesses the capabilities of new technologies and their possible application by EOSDIS; provides technical assistance in resolving problems, as required; and coordinates the planning, implementation, and integration of major upgrades as EOSDIS evolves over its operational life. The ESDIS Project provides a system-level capability that coordinates the sustaining engineering functions performed by each EOSDIS element and performs system-level sustaining engineering activities.

The EOSDIS elements provide tools and other capabilities to support element and system-level sustaining engineering activities. The implementation of these capabilities varies among EOSDIS elements. At ECS, sustaining engineering personnel share development facility resources; sustaining engineering capabilities will be established for long-term operational support. EDOS and EBnet have dedicated non-operational resources that provide sustaining engineering functions. Other EOSDIS elements allocate hardware and software components from their overall system configuration as necessary to support sustaining engineering activities.

4.4.1.1 Operations Monitoring and Trend Analysis

The sustaining engineering function in each EOSDIS element monitors its internal operations and evaluates its system performance and resource utilization in supporting EOS mission operations. The methods and procedures used at each site are described in detail in the applicable system design documentation and operations manuals.

Each element also provides summary status and performance reports and operations management data to the SMC for use in evaluating overall system performance and performing trend analyses to predict future operations requirements. Trend information will be used to revise system-wide policies and procedures, in order to maximize EOSDIS end-to-end performance.

4.4.1.2 Impact Analysis and Technology Assessment

EOSDIS sustaining engineering personnel maintain the system-level requirements and evaluate the impact of proposed changes to these requirements on EOSDIS's ability to support new and ongoing EOS missions. EOSDIS sustaining engineering personnel also evaluate developments in computer system, communications, and other technologies that may be used to meet current or future system requirements. Changes are typically recommended to enhance EOSDIS mission support functions or performance, expand system capacity, improve system or element RMA, or reduce life-cycle costs.

4.4.1.3 System Evolution Planning and Coordination

The ESDIS project coordinates the efforts of the EOSDIS elements in defining, planning, integrating, and testing major system releases. Major system releases may include, for example, the addition of system functionality and capacity to support new missions or other changes in support requirements; integration of new technologies to improve system performance; and simultaneous installation of a number of maintenance changes to correct system errors and deficiencies.

Each EOSDIS element is responsible for developing and testing system changes and for verifying system-level functional, performance, and interface capabilities prior to installation in the operational system. The SMC coordinates inter-element tests, including independent verification and validation activities and operational readiness tests, as required. The SMC also coordinates the transition activities and schedules for installing each major release in the EOSDIS operational configuration.

4.4.2 System Maintenance

System maintenance includes the resources, personnel, equipment and tools, documentation, and logistics support required to identify, design, fabricate or acquire, install, and test all changes to EOSDIS hardware, software, and firmware, and the logistics and administrative support required to support these activities.

Each EOSDIS element's O&M organization is responsible for performing the system maintenance activities required to correct defects and errors, perform preventive maintenance procedures to support system operations, install vendor-provided field modifications, and implement changes required to enhance system capabilities and maintain compatibility with other EOS systems. At the DAACs and other facilities that host EOSDIS functions, maintenance of these functions is performed by the host organization or shared between host and EOSDIS in accordance with the support arrangements applicable to each site.

Each EOSDIS site provides summary reports of maintenance plans, schedules, and status to the SMC, which maintains an EOSDIS-wide maintenance schedule and master system configuration records for EOSDIS systems. Integration of all EOSDIS system changes into end-to-end EGS operations is coordinated by the SMC to minimize the impact to ongoing EOS mission support.

All changes to operational EOSDIS elements made during system maintenance are verified before installation in the operational system. System maintenance is planned, scheduled, and executed at the element level in accordance with ESDIS project policies and guidelines. The SMC maintains a master list of EOSDIS maintenance plans and schedules and coordinates the schedule for integrating maintenance changes at the operations level, to ensure that there is no interruption to EOS mission support

Logistics support for the EOSDIS elements is performed at each site in accordance with NASA and ESDIS Project policies and with the logistics requirements specified by each element's development organization. Local site managers are responsible for providing the spares and expendables needed to sustain site O&M functions to meet EOSDIS mission operations support requirements. Each site maintains utilization and status information about its logistics activities and provides summary reports to the SMC for use in system-wide logistics monitoring, trend analysis, and coordination.

4.4.3 EOSDIS Configuration Management

EOSDIS operational resources are controlled through a configuration management process, in accordance with ESDIS project policies and guidelines. The configuration of each EOSDIS element is frozen at the time of operational acceptance. Each element is responsible for maintaining the configuration of its system components and the associated documentation; tools, equipment, and materials; and facilities. Each element has established configuration control procedures consistent with ESDIS policies.

The ESDIS project coordinates the integration of all changes to EOSDIS elements in the end-to-end system configuration. Changes are installed at local sites after all pre-installation and verification activities are completed, and with the approval of the ESDIS project. Operations data, tools, and updated documentation are migrated to the operational environment along with the associated hardware and software.

The ESDIS Project configuration control board maintains system-level configuration control of all EOSDIS elements. The SMC maintains a master configuration list for all EOSDIS operational system components. Element configuration status reports are provided to the SMC for use in maintaining a configuration change audit trail, generating configuration change reports, and updating the master list.

4.4.4 Data Management

The ESDIS Project data management function is used to generate, identify, control, and distribute the engineering and technical management information required to support the Project. The data management function includes the establishment and enforcement of uniform standards for document and data formats, access and maintenance, and control over changes and updates.

The data management processes established during EOSDIS development are used throughout the EOSDIS life cycle to maintain the currency of EOSDIS documentation and technical data, and to make these materials available to ESDIS Project staff, EOSDIS O&M personnel, and EOS users to support execution of their EOS responsibilities.

4.4.4.1 Documents and Technical Materials

The accuracy and currency of the information developed during EOSDIS implementation must be maintained to ensure the integrity of this information over the EOS Program’s planned 20-year lifetime. Master copies of all project management policies and procedures, study reports, and EOSDIS elements’ system and operations documentation are maintained at specific EOSDIS facilities, as appropriate.

All relevant materials are updated, or new materials prepared or procured, whenever system components or operational capabilities or procedures are modified or replaced. All documentation updates are made in accordance with configuration management procedures. Distribution lists are maintained for the various classes of documentation, and notifications of the availability of updates and materials are disseminated accordingly.

4.4.4.2 System Operations Data

The integrity of each element’s data bases, software, and other system-resident information is critical to sustain EOS operations and maintain confidence in the results of EOS-based research.

The EOSDIS data management function provides for safeguarding the accuracy and currency of these materials.

Master and backup copies of each EOSDIS element's system software and firmware, applications software, the contents of operational data bases, and other system-resident information are maintained at element facilities and at designated alternate sites. Master and backup copies of centralized EOSDIS system operations information are maintained by the ESDIS project data management function and made available to the appropriate EOSDIS elements in accordance with project configuration management procedures.

4.4.4.3 Science Data

Protecting EOS science data while making it available for scientific research is a crucial challenge for EOSDIS data management. The process for establishing and maintaining the EOSDIS science data archive is summarized in Section 4.2.1.

4.4.5 Training and Certification

The EOSDIS elements provide for the training and certification of element personnel, both Government and contractor, in the operation and maintenance of their operational systems and in executing auxiliary activities as required.
Training is conducted at the appropriate site(s) in accordance with an approved training plan, without interfering with EOS operations. All personnel receive instruction to familiarize them with the overall EOS program and with EOSDIS and local security requirements and procedures, in addition to specialized training tailored to the responsibilities of each job classification. Periodic refresher training and recertification is conducted for all O&M positions to maintain and improve the operational knowledge and skills of current staff.

Each element's training program includes formal classroom presentations and laboratory training; on-the-job training; self-study courses to supplement formal training courses; and vendor-provided training courses for EOSDIS equipment, where applicable. Simulators, test systems, and other training tools and methods to provide hands-on practice are used wherever practical. A formal certification process tests the students' grasp of essential materials and demonstrates their proficiency at performing the duties of the position for which they are being trained.

4.4.6 Operations Readiness Verification

EOSDIS operations readiness verification is the culmination of EOSDIS system integration and test activities. EGS readiness to support launch and mission operations for each EOS mission is demonstrated by successful acceptance testing at each element; compatibility tests between EOSDIS elements and other EGS facilities; and mission simulations to validate operations procedures and to provide a realistic environment for completing operator training. The EOSDIS then participates in tests conducted to verify the operational readiness of the entire EOS operational system to support the new mission and maintain ongoing operations.

Operations readiness tests consist of informal and formal end-to-end tests to exercise the full range of spacecraft and ground system capabilities. Informal tests include real-time data flows to test the mission-critical elements of the EOSDIS and other EGS capabilities, and to determine the effectiveness of operations plans and procedures and personnel training. Tests of the data processing elements use live or recorded instrument data as input, to verify that the science algorithms to be used in standard data production produce the expected output.

Formal operations readiness tests consist of end-to-end data flows based on realistic mission operations scenarios. All EOSDIS elements and other facilities required to support the test are configured as for live mission support. The operations staff at each facility executes the mission support activities specified in the test script. The mission's instruments and other spacecraft components, or data recorded from them, are used whenever possible to ensure that the spacecraft and ground system are fully compatible under operational conditions. Each scenario is executed to completion; test logs are maintained at each facility and test output and other results are recorded for post-test analysis. A full debriefing of each test is conducted to verify the results, evaluate anomalies, and identify any required corrective actions and retesting.

The results of operations readiness testing and other operations readiness verification activities are presented by the MOM at the mission Operations Readiness Review, typically conducted about 90 days before the scheduled launch readiness date.